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ORIGINAL INVESTIGATION

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Predictors of cognitive complaints in older adults: a mixture regression approach

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Abstract The present paper examined four hypotheses regarding the nature of cognitive complaints in older adults. Analyzing data from 607 participants (mean age = 62.9 years, SD = 0.92 years, 59–65 years), we tested the influence of actual cognitive test performance, negative age stereotypes, depressive symptoms, neuroticism, and conscientiousness on cognitive complaints. Bivariate correlations confirmed relations of all hypothesized predictors with cognitive complaints. However, considering all predictors simultaneously in an OLS regression analysis, particularly depressive symptoms and neuroticism were revealed as accounting for large proportions of variance in cognitive complaints. Utilizing mixture regression analyses, evidence for distinct subgroups was obtained in which cognitive complaints were explained by different predictor patterns.

Keywords Cognitive complaints · Memory · Mixture regression · Personality · Depression

Introduction

With current publicity and awareness of the importance of dementia in general and Alzheimer's disease in particular, older adults often present themselves to general practitioners and to specialist services, such as memory clinics, with complaints about difficulties in memory, attention, and daily planning routines. In line with this development, cognitive complaints have become a key aspect of several diagnostic concepts of cognitive functioning in older adults, e.g., mild cognitive impairment (MCI; see Bischkopf et al. 2002 for an overview) or age-associated cognitive decline (AACD; see Levy 1994). However, despite its importance for older adults' mental health, the question of what cognitive complaints actually reflect still represents a controversial issue.

There are four major psychological hypotheses that have been proposed regarding the determinants of cognitive complaints. The amount of cognitive complaints may reflect (1) actual cognitive test performance (e.g., Petersen et al. 1999; Burns and Zaudig 2002), (2) negative age stereotypes (e.g., McDonald-Miszczak et al. 1995; Martin and Zimprich 2003), (3) depressive symptoms (e.g., Bolla et al. 1991; Zimprich et al. 2003), or (4) one or several personality traits, for example, neuroticism and conscientiousness (e.g., Hänninnen et al. 1994; Lane and Zelinski 2003).

In the case of the first hypothesis (actual cognitive test performance), several authors have demonstrated that cognitive complaints tend to increase with advancing age while actual performance on average decreases with advancing age (e.g., McDonald-Miszczak et al. 1995; Schaie 1996; McCurry et al. 1999; Ponds et al. 2000). Therefore, early studies have tested the assumption that age differences in cognitive complaints might reflect age differences in cognitive test performance. However, most studies revealed weak relations between self-rated memory and performance in standard memory tests (see Hertzog and Hultsch 2000). Despite these results from basic research, within the clinical context several authors hypothesized that cognitive complaints might be a key indicator for early cognitive decline in old age and, therefore, one might assume that decreases in actual performance underlie cognitive complaints at least to a substantial degree (e.g., Scogin and Prohaska 1993; Geerlings et al. 1999; Jonker et al. 2000; Burns and Zaudig 2002).

The second hypothesis regarding the nature of cognitive complaints states that cognitive complaints are influenced by negative age stereotypes, as reflected in implicit theories of aging. Implicit theories have been defined as informal constructions held by individuals about psychological phenomena, such as memory or intelligence (cf. Sternberg 1987). Implicit theories are

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widely shared within a culture or subculture, contributing to stereotypes about characteristic traits or behaviors of members of a certain group—such as "older adults" (see Kite et al. 1991). In general, adults in Western cultures appear to expect that psychological functioning in old age will show a loss trajectory with increasing age, with the onset of difficulties occurring as early as at middle age (e.g., Heckhausen et al. 1989). Moreover, and most important for the present issue, McDonald-Miszczak et al. (1995) stated that people might use their implicit theories of age-related decline in judging their own abilities. This hypothesis was most recently investigated by Lane and Zelinski (2003), who analyzed age-related changes in cognitive complaints in relation to age-related changes in memory performance. They found that age (and not memory performance) was the only independent predictor of changes in cognitive complaints.

Thirdly, some authors suggested that affective states might be a mediating variable in the subjective–objective cognitive performance relation. Accordingly, a growing body of research has reported that subjective cognitive complaints are associated with depressive symptoms, rather than with actual cognitive performance (Hänninen et al. 1994; Smith et al. 1996; Levy-Cushman and Abeles 1998; Jorm et al. 2001; Comijs et al. 2002; Zimprich et al. 2003). These authors assume that depressivity results in an amplification of subjective complaints regarding one's cognitive performance. Although there are also some inconsistent findings, several recent studies have provided support for the assumption that depressivity results in increased subjective complaints regarding one's cognitive performance (e.g., Zimprich et al. 2003).

Finally, a more recent hypothesis is the proposition that cognitive complaints reflect rather stable personality traits (e.g., Comijs et al. 2002). The two personality dimensions most prominently discussed as sources for cognitive complaints are neuroticism and conscientiousness. With respect to neuroticism, it has been shown that it is associated with health complaint ratings in general, independently of objective health, and that people scoring high on neuroticism are more likely to recall negative things about themselves (e.g., Martin 1985). Thus, when asked about their cognitive performance, persons with high scores in neuroticism might also be more likely to focus on cognitive problems, rather than on successful episodes (Ponds and Jolles 1996). With respect to the second personality trait, conscientiousness, the assumption is that people high in conscientiousness, which includes being competent, orderly, dutiful, achievement-striving, self-disciplined, and deliberative, display a higher level of health-related self-awareness and are more likely to try to engage in preventive health-behaviors (Ingledew and Brunning 1999; Lane and Zelinski 2003). For example, if mnemonics are seen as preventive measures regarding memory failures, it can therefore be expected that those high in conscientiousness would more frequently make use of mnemonics than those low in conscientiousness and, at the same time, be more aware of possible memory problems (see Gilewski et al. 1990; Lane and Zelinski 2003). Consequently, one can expect that higher scores in conscientiousness predict more cognitive complaints.

The present study had two major goals:

1. It aimed at *simultaneously* addressing the four hypotheses regarding the correlates of cognitive complaints. Using data from the Interdisciplinary Study on Adult Development (ILSE; Martin et al. 2001), we tested the hypotheses that cognitive complaints might reflect actual cognitive performance, depressive symptoms, negative age stereotypes, neuroticism, and/or conscientiousness.
2. The second aim of the present study was to explore the possibility that there may be *different subgroups* of older adults with respect to the factors underlying their cognitive complaints. In most previous studies summarized above, the associations between cognitive complaints and the hypothesized variables have been investigated under the assumption that a single model is sufficient to characterize the relations between cognitive complaints and their predictors in different individuals. Thus, it has been assumed that all individuals are homogenous with respect to the determinants of cognitive complaints. This assumption, however, may mask differential effects of predictor variables in different subgroups of older adults—for example, factors that play an important role for predicting cognitive complaints for some elderly persons may be inconsequential for others. Hence, it might be that a single model is not adequate to characterize the relations between cognitive complaints and their predictors in different individuals. In contrast to previous studies, we therefore explored the possibility that individuals might be heterogeneous with respect to the determinants of cognitive complaints. We used a *mixture regression approach* to examine possible heterogeneity with respect to cognitive complaints in the sample. The mixture regression approach simultaneously classifies individuals into subgroups on the basis of the *relations* between cognitive complaints and the predictor variables, and estimates the influences of predictor variables on cognitive complaints for each class identified. Thus, the classification of individuals is based on whether participants respond to the determinants of cognitive complaints in a similar manner. For individuals within a class, the influence of predictor variables on cognitive complaints is the same, whereas for different classes the influence of predictor variables on cognitive complaints is different.

In sum, in the present paper we simultaneously investigated the four major hypotheses that have been proposed regarding the correlates of cognitive complaints. Self-reported cognitive complaints may reflect

(1) actual cognitive performance, (2) negative age stereotypes, (3) depression, or (4) personality traits (i.e., neuroticism and conscientiousness). In addition, we explored the possibility that a single model may not be adequate to characterize the relations between cognitive complaints and their predictors in different subgroups of older adults. To do so, we used a mixture regression approach to investigate the constellation and explanatory power of predictor variables in different subgroups of the sample.

Methods

Participants

The data for this study were collected as part of the Interdisciplinary Study on Adult Development (ILSE; Martin et al. 2001), an ongoing interdisciplinary longitudinal study on the psychological, physical, and social antecedents and consequences of aging. Included in the present study were those $n = 607$ subjects (of originally 695 persons) who participated at the first measurement occasion (1994) and who had complete data records for the variables of interest. Mean age was 62.9 years (SD = 0.92 years, 59–65 years), with 48% of the sample being female. Mean years of schooling was 9.91 (SD = 2.22 years, 4–16 years).

Measures

Cognitive complaints

Cognitive complaints were measured using six items from the Nuremberg Self-assessment List (NSL; a subscale from the Nuremberg Inventory of Old Age—a German gerontological test battery; Oswald and Fleischmann 1995; see Martin and Zimprich 2003 for a similar procedure). This questionnaire requires the self-assessment of problems in several domains of everyday life. Six items tapping cognitive problems were selected, namely, (1) ''Lately, I occasionally confuse names, phone numbers or dates'', (2) ''Lately, I have more difficulties in planning a journey or other undertakings'', (3) ''Lately, I find it difficult to concentrate on a task'', (4) ''Lately, I now and then forget the birth dates of relatives or close acquaintances'', (5) ''Lately, I find it difficult to follow the train of thought of others'', and (6) ''Lately, I occasionally forget names and numbers''. Each item is scored from 0 = ''completely wrong'' to 3 = ''completely true'' on a four-point Likert scale. The six items were added in order to form an indicator of cognitive complaints (possible range: 0 to 18 points). Cronbach's alpha for this composite score was 0.78. Note that for cognitive complaints, higher scores indicate more pronounced cognitive complaints.

Memory

Memory was measured using a picture recall task, a delayed picture recall task, a word recall task, a word recognition task, and a memory for activities task from the Nuremberg Inventory of Old Age (Oswald and Fleischmann 1995). For the picture recall task, seven pictures of objects were presented to the participants for 3 s each. After presentation of all pictures, participants were immediately asked to recall as many objects as possible. Scored was the number of correctly recalled objects (possible range: 0–7 points). The delayed picture recall task demanded recall of the same seven objects after a 30-min interval. Scored was the number of correctly recalled objects (possible range: 0–7 points). For the word recall task, a list of 12 common, two-syllable German words was read aloud to the participants. After presentation, participants were immediately asked to recall as many words as possible. Scored was the number of correctly recalled words (possible range: 0–12 points). For the word recognition task, after a 30-min interval 24 words, 12 of them being identical to the words presented beforehand, the other 12 being distractor words, were read aloud to the participants. Participants had to decide which words they had been presented already in the word recall task. Scored was the number of correctly recognized words (possible range: 0–12 points). For the memory for activities task, at the end of the cognitive testing session subjects were asked to report, i.e., correctly describe, all cognitive tests they had taken during the session. Scored was the number of correctly recalled tests (possible range: 0–12 points). A maximum likelihood factor analysis indicated that the results of these five memory measures loaded on a common factor. A composite indicator of memory was formed by estimating factor scores, which were subsequently T-standardized (mean = 50, SD = 10) in order to facilitate interpretation.

Intellectual performance

Intellectual performance was measured using the triad short form of the German version of the Wechsler Adult Intelligence Scale-Revised (WAIS-R) proposed by Kaufman et al. (1991). This short form consists of the WAIS-R subtests Information, Picture Completion, and Digit Span. A maximum likelihood factor analysis indicated that the results of the three intellectual performance measures loaded on a common factor. A composite indicator of intellectual performance was formed by estimating factor scores, which were subsequently T-standardized (mean = 50, SD = 10) in order to facilitate interpretation.

Negative age stereotypes

Negative age stereotypes were measured using the six items from the ILSE self-assessment questionnaire

capturing negative age stereotypes, namely, (1) ''Like every age, so does old age have its beautiful sides of life'', (2) ''In old age, one gets lonely'', (3) ''In old age, one doesn't have the strength for many physical activities'', (4) ''In old age, one gets helpless again'', (5) ''As an old person, one isn't respected any more'', and (6) ''In old age, one can't expect anything more from life''. Each item is scored from 0 = ''completely wrong'' to 6 = ''completely true'' on a seven-point Likert scale. Item 1 was reversed, and thereafter the six items were added in order to form an indicator of negative age stereotypes (possible range: 0–36 points). Cronbach's alpha for this composite score was 0.71. Note that for negative age stereotypes, higher scores indicate more pronounced negative age stereotypes.

Depressive symptoms

Depressive symptoms were measured using a 20-item self-rating depression scale (SDS; Zung and Zung 1986). Each item is Likert-scaled from 1 = ''never'' to 4 = ''always''. As an indicator of depressive symptoms, the total score was used (possible range: 20–80 points). Cronbach's alpha of the total score was 0.78. Note that for depressive symptoms, higher scores indicate more depressive symptoms.

Neuroticism and conscientiousness

Participants were administered the short form of the German Revised NEO-Personality Inventory (NEO-FFI; Costa and McCrae 1992; Borkenau and Ostendorf 1993). This self-report questionnaire contains 60 self-statements that the subject rates on a five-point Likert scale (0 = ''strongly disagree'' to 4 = ''strongly agree''). The NEO-FFI provides scores for each component of the five-factor model of personality—neuroticism (N), extroversion (E), openness to experience (O), agreeableness (A), and conscientiousness (C). Following theoretical assumptions, for the present analyses we included the subscales neuroticism and conscientiousness. The 12 items tapping neuroticism were added to form an indicator of neuroticism (possible range: 0–48), and the 12 items tapping conscientiousness were added to form an indicator of conscientiousness (possible range: 0–48). For neuroticism and conscientiousness, Cornbach's alphas were 0.74 and 0.77, respectively. Note that for both neuroticism and conscientiousness higher scores indicate more pronounced neuroticism and conscientiousness.

Statistical modeling

To examine the associations between cognitive complaints and the predictor variables for the whole sample, we used OLS regression analyses (cf. Cohen and Cohen 1983). Additionally, we employed mixture regression analysis in order to model possibly heterogeneous associations among the predictor variables and cognitive complaints in different subgroups of the sample. In finite mixture models, it is assumed that a sample of observations arises from a specified number of underlying subpopulations in unknown proportions (cf. McLachlan and Peel 2000). DeSarbo and Cron (1988) proposed a conditional mixture model that enables the estimation of separate regression functions and corresponding membership in a number of subpopulations or classes using maximum likelihood. This approach allows to simultaneously estimate the probabilistic classification of individuals by their cognitive complaints, and to explain cognitive complaints by a set of predictor variables in each subpopulation or class. For a detailed description of the statistical modeling applied, the reader is referred to the Appendix.

Results

Descriptive results

Participants were young old adults who showed a substantial degree of cognitive complaints (mean = 5.52, SD = 3.95, min = 0.00, max = 18.00). Overall, memory performance was in the medium range, with no one displaying severe memory deficits (mean = 28.94, SD = 5.22, min = 14.00, max = 45.00). Depressive symptoms were on a normal level (mean = 34.77, SD = 7.00, min = 20.00, max = 60.00). In addition, the entire sample appeared to be representative for neuroticism (mean = 18.85, SD = 6.89, min = 1.00, max = 40.00; 50th percentile) and conscientiousness (mean = 35.20, SD = 5.13, min = 20.00, max = 47.00; 55th percentile). Table 1 summarizes the sample correlations between cognitive complaints and the predictor variables as well as the sample correlations among the predictor variables.

Cognitive complaints correlated significantly with all predictor variables, except for age. Directions of correlations indicated that a higher level of cognitive complaints was related to fewer years of formal school education, lower memory performance, lower intellectual performance, more pronounced negative age stereotypes, more depressive symptoms, higher level of neuroticism, and lower level of conscientiousness. Depressive effect (0.525) and neuroticism (0.488) displayed the highest correlations with cognitive complaints. With regard to intercorrelations between predictors, a high correlation was obtained between depressive symptoms and neuroticism (0.639), indicating that higher scores in neuroticism were related to more depressive symptoms and that, in the entire sample, both predictors shared 40% common variance. In addition, relatively high correlations (0.31–0.37) were revealed between age stereotypes and depressive symptoms as well as neuroticism (indicating that more negative age

Table 1 Sample correlations of indicator variables[a]

	1	2	3	4	5	6	7	8
1. Complaints								
2. Age	0.085							
3. Years of schooling	−0.176	−0.065						
4. Memory	−0.171	0.034	0.185					
5. Intellectual performance	−0.207	−0.026	0.442	0.316				
6. Negative age stereotypes	0.266	−0.017	−0.106	−0.140	−0.194			
7. Depressive symptoms	0.525	0.018	−0.160	−0.166	−0.282	0.371		
8. Neuroticism	0.488	0.036	−0.167	−0.140	−0.333	0.367	0.639	
9. Conscientiousness	−0.253	−0.032	−0.019	0.055	0.011	−0.162	−0.305	−0.330

[a] $n = 607$; correlations ≤ -0.105 or ≥ 0.105 are statistically significant at $p < 0.05$

stereotypes were related to more depressive symptoms and higher neuroticism, respectively), and between conscientiousness and depressive symptoms as well as neuroticism (indicating that lower conscientiousness was related to more depressive symptoms and more neuroticism, respectively).

OLS regression analyses

Since all hypothesized predictors correlated with cognitive complaints, in a second step, OLS regression analyses were used to examine which predictor variables were most powerful in predicting cognitive complaints in the overall sample after controlling for sex, age and years of schooling, and considering other predictor variables simultaneously (see Table 2).

The baseline model 0 revealed that the basic demographic variables sex, age, and years of schooling explained only 3.7% of the variability in cognitive complaints. Here, years of schooling was the only significant predictor, indicating that with every additional year of formal school education, the level of cognitive complaints decreases by 0.306 points. In a second model (model 1), actual memory and intellectual performance were included into the regression. This resulted in an additional amount of 3.4% of explained variance in cognitive complaints. Formal school education, memory and intellectual performance were significant predictors of cognitive complaints. Next, in model 2, negative age stereotypes were added, and the amount of explained variance increased by 4.9% up to 12%. In this regression, considering basic information (sex, age, and education), memory and intellectual performance, as well as negative age stereotypes simultaneously, the latter variable was the strongest predictor. Interestingly, besides intellectual performance, also age was a significant predictor of cognitive complaints in this case. In model 3, additionally containing depressive symptoms, the explained variance in cognitive complaints was increased by 18.7%, and depressive symptoms were revealed as the strongest predictor while intellectual performance was no longer significant. However, age, negative age stereotypes and, in addition, sex significantly predicted memory complaints as well. Finally, we added neuroticism and conscientiousness to the regression equation (model 4). With all predictors considered simultaneously, 35% of the overall sample variance in cognitive complaints could be explained. Of the hypothesized predictor variables, in the final model, depressive symptoms and neuroticism were the two most powerful predictors, while test (memory and intellectual) performance and age

Table 2 Parameter estimates of OLS regression analysis[a]

	Model 0	Model 1	Model 2	Model 3	Model 4
Sex	−0.185*	−0.431*	−0.467*	−0.811*	−1.066*
	(−0.023)	(−0.055)	(−0.059)	(−0.103)	(−0.135)
Age	0.319*	0.309*	0.335*	0.305*	0.268
	(0.074)	(0.072)	(0.078)	(0.071)	(0.062)
Years of schooling	−0.306*	−0.158*	−0.149*	−0.115*	−0.118*
	(−0.173)	(−0.089)	(−0.084)	(−0.065)	(−0.067)
Memory		−0.037*	−0.028*	−0.012*	−0.009*
		(−0.093)	(−0.072)	(−0.031)	(−0.024)
Intellectual performance		−0.062*	−0.048*	−0.021*	−0.014*
		(−0.156)	(−0.122)	(−0.053)	(−0.035)
Negative age stereotypes			0.203*	0.065*	0.031*
			(0.228)	(0.073)	(0.034)
Depressive symptoms				0.271*	0.185*
				(0.481)	(0.329)
Neuroticism					0.139*
					(0.242)
Conscientiousness					−0.059*
					(−0.077)
r^2	0.037*	0.071*	0.120*	0.307*	0.349*
Δr^2		0.034*	0.049*	0.187*	0.042*

[a] Standardized estimates in parentheses; $n = 607$; *, $p < 0.05$

stereotypes were no longer significant predictors of cognitive complaints. Again, apart from conscientiousness, sex was also a significant predictor.

Mixture regression analysis

The mixture regression model was applied to the data for $C = 1$ to 5 latent classes. The log-likelihoods and CAIC values are listed in Table 3. Based on the minimum value of the CAIC statistic, we selected $C = 2$ as the appropriate number of latent classes. This solution had a log-likelihood of −1,485.104. The entropy value of 0.828 indicated that the mixture components are relatively well separated, i.e., the posterior probabilities for class membership are (on average) close to either 1 or 0. Note that the solutions based on more latent classes had log-likelihoods very close to that of the two-class solution, but with considerably lower entropy statistics.

Table 4 depicts the parameter estimates of the mixture regression analysis for two latent classes. In class 1, which contained 518 participants, the pattern of regression coefficients was very similar to that of the OLS regression for the entire sample. More specifically, sex was negatively associated with cognitive complaints, indicating that women reported less complaints. For age, no significant coefficient emerged. Years of schooling were negatively related to cognitive complaints. Memory, intellectual performance, and negative age stereotypes were not significantly associated with cognitive complaints in class 1. For depressive symptoms, a coefficient of 0.188 was estimated in class 1, implying that a one-point increase in depressive symptoms was accompanied by an increase of 0.188 points in cognitive complaints. Neuroticism was positively related to cognitive complaints, showing that with a one-point increase in neuroticism, cognitive complaints increased by 0.102 points. Finally, conscientiousness was not significantly associated with cognitive complaints. According to the standardized estimates, in class 1, depressive effect was the strongest predictor of cognitive complaints ($\beta = 0.352$), followed by neuroticism ($\beta = 0.182$). In sum, predictors explained 30% of variance in cognitive complaints in class 1.

In class 2, which comprised 89 participants, the influences of the predictor variables differed markedly. More specifically, sex, age and years of schooling had no statistically significant effect. In contrast, all four hypothesized variables significantly contributed to predicting cognitive complaints in class 2, even when taken into account simultaneously. Memory was positively, intellectual performance negatively associated with cognitive complaints. Negative age stereotypes had

Table 3 Fit statistics of the mixture regression models for classes $C = 1$ to 5

Number of classes C	Log-likelihood	CAIC	Entropy
1	−1,564.587	3,137.174	1.000
2	−1,485.104	2,987.208	0.828
3	−1,481.292	2,988.584	0.675
4	−1,478.785	2,992.570	0.656
5	−1,475.680	2,995.360	0.672

Table 4 Parameter estimates of mixture regression analysis[a]

	Class 1 ($n = 518$)	Class 2 ($n = 89$)
Sex	−0.923*	−0.033*
	(−0.126)	(−0.023)
Age	0.264*	−0.065*
	(0.066)	(−0.085)
Years of schooling	−0.136*	0.015*
	(−0.082)	(0.047)
Memory	−0.016*	0.028*
	(−0.044)	(0.388)
Intellectual performance	−0.013*	−0.046*
	(−0.034)	(−0.599)
Negative age stereotypes	0.032*	−0.030*
	(0.038)	(−0.181)
Depressive symptoms	0.188*	−0.064*
	(0.352)	(−0.536)
Neuroticism	0.102*	0.094*
	(0.182)	(0.832)
Conscientiousness	−0.037*	0.031*
	(−0.051)	(0.199)
r^2	0.301	0.783*

[a]Standardized estimates in parentheses; *, $p < 0.05$

Table 5 Descriptive statistics of the two latent classes and the total sample[a]

	Class 1 ($n = 518$)	Class 2 ($n = 89$)	Total sample ($n = 607$)
Cognitive complaints	5.84*	3.69*	5.52
	(3.83)	(4.16)	(3.95)
	0–17	0–18	0–18
Sex	276 (53%) male	40 (45%) male	316 (52%) male
Age	62.90	63.00	62.90
	(0.92)	(0.93)	(0.92)
	59–65	61–64	59–65
Years of schooling	9.91	9.92	9.91
	(2.25)	(2.04)	(2.22)
	4–16	6–16	4–16
Memory	49.63*	52.17*	50.00
	(9.86)	(10.56)	(10.00)
	22–78	23–76	22–78
Intellectual performance	50.16	49.05	50.00
	(10.00)	(9.81)	(10.00)
	18–67	22–64	18–67
Negative age stereotypes	8.70	7.76	8.57
	(4.41)	(4.52)	(4.43)
	0–23	0–20	0–23
Depressive symptoms	35.13*	32.02*	34.77
	(7.01)	(6.61)	(7.00)
	20–60	20–49	20–60
Neuroticism	19.15*	17.09*	18.85
	(6.82)	(7.06)	(6.89)
	1–40	1–40	1–40
Conscientiousness	34.82*	37.40*	35.20
	(5.09)	(4.79)	(5.13)
	20–47	20–47	20–47

[a]Asterisk denotes mean difference significant at $p < 0.05$ between classes 1 and 2; standard deviation in parentheses, followed by range

a statistically significant negative effect on cognitive complaints. Moreover, depressive symptoms were also negatively related to cognitive complaints, implying that in class 2 those reporting more depressive symptoms likewise reported fewer cognitive complaints. Similarly to class 1, in class 2, neuroticism was positively linked to cognitive complaints, which implied that those higher in neuroticism reported more cognitive complaints. Finally, for conscientiousness a positive effect on cognitive complaints was estimated, which implies that in class 2 those higher in conscientiousness reported more cognitive complaints. According to the standardized estimates, in class 2, neuroticism was the strongest predictor of cognitive complaints ($\beta = 0.832$), followed by intellectual performance ($\beta = 0.599$). In sum, predictors explained 78% of variance in cognitive complaints in class 2.

To summarize, in the mixture regression approach, regression equations differed markedly in class 1 versus class 2. Most importantly, in class 2, actual memory and intellectual cognitive test performance had a significant effect on cognitive complaints, whereas in class 1 actual test performance had no statistically significant effect. Moreover, in class 2, negative age stereotypes were negatively associated with cognitive complaints, while in class 1 there was no statistically significant effect of negative age stereotypes. Furthermore, depressive symptoms showed a negative effect on cognitive complaints in class 2, whereas in class 1 they were positively associated with cognitive complaints. Finally, in class 2, conscientiousness exerted a positive influence on cognitive complaints, while in class 1 this influence was not statistically significant.

In a further analysis step, we aimed to shed some light on what differentiates class 1 from class 2 individuals. As summarized in Table 5, participants in class 2 reported significantly fewer cognitive complaints and showed significantly (albeit slightly) better memory performance. In addition, they reported significantly less depressive symptoms, were less neurotic, and had higher scores in conscientiousness. For all other predictor variables—age, formal school education, and negative age stereotypes—both classes had comparable mean levels.

Discussion

The first aim of the present study was to investigate the question of what cognitive complaints in old adults actually reflect. We simultaneously tested the influence of four hypothesized psychological predictors—actual test performance, negative age stereotypes, depressive symptoms, neuroticism and conscientiousness—on cognitive complaints.

Descriptive results on cognitive complaints

First of all, it seemed surprising that even in a relatively young sample of older adults with no evidence of clinically relevant memory problems, a rather substantial degree of subjective cognitive complaints was obtained. Although the mean level of the complaints score was in the lower third of the possible range, considering the administered questions (confusing names, telephone numbers or dates, forgetting the birth dates of relatives or close acquaintances, or names and numbers, and having difficulties in concentrating on a task, in following the train of thought of others, and in planning a journey or other undertakings), it seems remarkable that a sample of people in their early sixties reported substantial problems in these items. Thus, the present results underline the importance of subjective cognitive complaints already for young old adults.

Predictors of cognitive complaints in the entire sample

Analyzing *bivariate correlations* revealed that all hypothesized predictors, except for age (which, however, had only a small range, i.e., 59–65 years, in the present database, most probably explaining this result), were significantly related to cognitive complaints. In replicating earlier studies, this indicates that all four hypothesized psychological predictor groups do share common variance with cognitive complaints, underlining that all four predictor groups have to be discussed in the context of factors underlying cognitive complaints. Nevertheless, these results give only some initial hints regarding the question of which process might be of particular relevance. Assessing the individual correlations, depressive effect and neuroticism had the strongest relation to cognitive complaints. This is consistent with some of our previous findings (e.g., Zimprich et al. 2003). However, depressive symptoms and neuroticism were also revealed to be highly correlated with each other (see also Hayes and Joseph 2003)—in fact, even more so than with cognitive complaints. In sum, this points to the necessity of analyzing the influence of all predictors simultaneously, thereby controlling for the effects of other variables.

Therefore, *OLS regression analyses* were computed. Several novel findings emerged. In the final model with all predictors included, actual test performance and negative age stereotypes were not significant predictors of cognitive complaints. Thus, actual test performance and negative age stereotypes can be seen as playing a rather minor role in the prediction of subjective cognitive complaints in young old age. This conclusion is further supported by the different regression models computed. Adding actual test performance and negative age stereotypes only resulted in minimal increases in the amount of explained variance in cognitive complaints. In the bivariate correlation analyses, however, test performance and cognitive complaints, and negative age stereotypes and cognitive complaints correlated significantly. Thus, the question

remains which other predictors can be seen as capturing their influence. With respect to cognitive test performance, it was shown that its influence disappeared after including depressive symptoms into the equations. Hence, the influence of test performance on cognitive complaints seems to be partially captured by the influence of depressive symptoms. This is consistent with previous findings suggesting that depression can reduce cognitive performance (e.g., Fossati et al. 2002), and that negative effect results in an amplification of subjective complaints regarding one's cognitive performance (e.g., Hänninen et al. 1994; Smith et al. 1996; Levy-Cushman and Abeles 1998; Zimprich et al. 2003). With regard to negative age stereotypes, only in the final model, comprising neuroticism and conscientiousness, were negative age stereotypes no longer a significant predictor of cognitive complaints. This supports the conclusion that the assessed negative age stereotypes showed a partial overlap with these personality variables. Since the influence of age stereotypes remained significant (albeit smaller) after considering only depressive symptoms, the effect of these implicit models of age-related changes on cognitive complaints can not entirely be attributed to depression.

Another novel finding revealed by the OLS regression is that, despite the high bivariate correlation between neuroticism and depressive symptoms, both variables independently and most strongly predicted cognitive complaints. This is an important result, as it provides evidence for the particular relevance of these factors for cognitive complaints in old age. Moreover, it underlines the differential influence of both a more stable personality predisposition, such as neuroticism, and a more transient variable, such as depressive state. Both appear to act independently in driving subjective cognitive complaints. The particular importance of depressive symptoms in the interplay of the tested predictors of cognitive complaints in old adults is additionally highlighted by the different models computed. Adding depressive symptoms to the regression equation resulted in the largest increase of explained variance. However, even after controlling for depressive symptoms (which, in part, reflect cognitive complaints themselves), the independent and substantial influence of neuroticism remained. Finally, the same holds true for conscientiousness. With respect to conscientiousness, the OLS regression analyses revealed that conscientiousness negatively predicted cognitive complaints, indicating that with a lower level of conscientiousness, more complaints were reported. This is in contrast to the assumption that those high in conscientiousness would be more aware of possible memory problems, supposedly leading to more reported cognitive complaints (Gilewski et al. 1990; Lane and Zelinski 2003). The present results rather point to the opposite conclusion, i.e., those high in conscientiousness report less cognitive complaints (see Pearman and Storandt 2004 for similar findings).

Mixture regression

The main finding of the mixture regression was that two distinct subgroups emerged in which several predictors played a differential role—a main group, representing the majority of the sample, and a smaller subgroup, in which cognitive complaints seemed to be represented by distinct processes. For class 1, the resulting regression model resembles, in both the significant predictors and the direction of these effects, the final model in the OLS regression using the entire sample. Here, especially depressive symptoms and neuroticism, but not cognitive performance, predicted cognitive complaints. In class 2, a distinct pattern emerged. Here, all psychological predictors that are discussed in the literature were revealed as significant and *independent* predictors of subjective cognitive complaints—even cognitive performance, and even after controlling for depressive symptoms and neuroticism.

Analyzing mean level differences in the predictor variables between both subgroups, the smaller subsample seems to be a group of older adults high in cognitive functioning, reporting less cognitive complaints, less depressive symptoms as well as showing lower scores in neuroticism and higher scores in conscientiousness. This seems to indicate that, if depression and neuroticism are less pronounced, the influence of other variables such as actual performance can emerge. Moreover, the results allow one to speculate that in this cognitively high functioning subgroup, individuals might be more accustomed to a high cognitive performance level and, therefore, small performance changes might be even more salient to them, and might from there lead to amplified cognitive complaints. In addition, in this group, negative age stereotypes had an independent, but negative effect on cognitive complaints. Among the members of this subgroup, fewer negative stereotypes were associated with more reported complaints. Accordingly, especially those individuals with a positive general attitude regarding the correlates of aging were those who reported more cognitive complaints. Possibly, those with rather positive expectations about aging try to "live up" to their expectations and, hence, become unduly distressed even by small cognitive failures, which, in turn, might result in unjustified and exaggerated cognitive complaints. A similar finding was obtained for depressive symptoms—the less depressive symptoms, the more cognitive complaints were reported within this group. This finding stands not only in contrast to the larger group but also in contrast to most parts of the literature (see Zimprich et al. 2003). In this sub-sample, cognitive complaints apparently were not amplified by a depressive state. What do cognitive complaints reflect in this subgroup? Some initial evidence could be obtained from the results regarding the personality trait measures. Firstly, with respect to conscientiousness, a pattern opposite to those of the larger subgroup and the entire sample was obtained. In class 2, higher levels

of conscientiousness were related to more cognitive complaints, which is consistent with the interpretation by Lane and Zelinski (2003) that those high in conscientiousness may be more aware of possible memory problems, supposedly leading to more reported cognitive complaints. Secondly, with respect to neuroticism, the results were comparable between both subgroups. In both samples, higher neuroticism was associated with more reported complaints. Thus, cognitive complaints seem to be very much enhanced by a neurotic personality—regardless of the subgroup. Hence, this latter effect can be qualified as a very robust finding in the context of factors underlying cognitive complaints, which is supported by the large effect sizes for the influence of neuroticism on cognitive complaints in both sub-samples (cf. Gilewski et al. 1990; Ponds and Jolles 1996).

One might speculate whether the individuals in class 2, who generally reported lower levels of cognitive complaints, are in an early stage of developing cognitive complaints—that is, the two classes found in the mixture regression analyses might differ because the individuals in these two different classes are in different phases of the process leading to cognitive complaints. Maybe in the beginning of the process (e.g., noticing the first severe, or repeating failures), different factors affect the development of cognitive complaints, which, in turn, might have a feedback on neuroticism or depressive effect by increasing these.

One shortcoming of the mixture regression analyses is that, despite using all the data available, there was no possibility to replicate the stratification of the sample into two classes. Further studies using other large-scale samples might try to fill this gap. Still, despite being an exploratory method, our results indicate that it seems promising to investigate samples of elderly for the presence of subgroups that show a rather distinct pattern of relations between predictor and outcome variables. By doing so, the understanding of which factors lead to cognitive complaints might be improved.

Another limitation that has to be acknowledged is that our reported analyses rest on cross-sectional data, and that this correlational approach does not allow to definitely test any causal relationships that might seem plausible. Thus, further studies will have to examine longitudinal data in order to extend the present findings, and to test some of the conclusions presented above.

To summarize, substantial cognitive complaints were found even in a rather young sample of older adults. In particular, a depressive state and a neurotic personality trait were revealed as playing important and independent roles in predicting cognitive complaints. Utilizing mixture regression analyses, this finding was qualified insofar as we found evidence for two distinct subgroups in which different predictor patterns were responsible for explaining cognitive complaints.

Appendix

Detailed description of statistical modeling

Let y_i be the measure of cognitive complaints for individual i ($i = 1, \ldots, I$). Assume that individuals come from a population that is composed of a mixture of C unobserved classes, which have relative sizes $\lambda_1, \ldots, \lambda_C$, with $0 \le \lambda_c \le 1$, and $\sum_{c=1}^{C} \lambda_c = 1$. The distribution of y_i, given that individual i comes from class c, is from the exponential family and may be denoted as $f_{i|c}(y_i)$. Given class c, the expectation of the y_i is denoted as ϑ_{ci}. Within classes, these expectations are modeled as a function of a set of P ($p = 1, \ldots, P$) predictor variables and the parameter vector b_{pc} in class c (cf. Wedel and DeSarbo 1995):

$$g(\vartheta_{ci}) = \sum_{p=1}^{P} x_{ip} b_{pc} \tag{1}$$

where $g(\cdot)$ is the link function, which links the expectations to the predictor variables. Within classes, the b_{pc} are the same, whereas across classes they are different. Because our dependent variable (cognitive complaints) is normally distributed, we utilized a normal mixture regression model (cf. DeSarbo and Cron 1988). For the normal mixture, y_i is distributed as a finite sum or mixture of conditional normal densities:

$$y_i \sum_{c=1}^{C} \lambda_c (2\pi\sigma_c^2)^{-1/2} \exp\left[\frac{-(y_i - \mathbf{x}_i \mathbf{b}_c)^2}{2\sigma_c^2}\right] \tag{2}$$

where $\mathbf{x}_i = (x_p)_i$ and $\mathbf{b}_c = (b_p)_c$. Estimates of λ_c, σ_c^2, and b_{pc} are obtained by maximizing the likelihood:

$$L = \prod_{i=1}^{I} \left[\sum_{c=1}^{C} \lambda_c (2\pi\sigma_c^2)^{-1/2} \exp\left[\frac{-(y_i - \mathbf{x}_i \mathbf{b}_c)^2}{2\sigma_c^2}\right]\right] \tag{3}$$

This likelihood function can be maximized using the iterative EM algorithm (Titterington 1990). The EM algorithm is based on the notion that the likelihood function contains missing observations, i.e., the 0/1 membership of individuals in the c classes. If these were known, maximization of (3) would be straightforward. Based on a multinomial distribution of the class membership, the expectation of the likelihood can be formulated. This involves calculating the posterior class membership probabilities according to Bayes rule and the current parameter estimates and substituting them into the likelihood. Once this is accomplished, (3) can be maximized. A detailed description of this iterative EM algorithm is given by DeSarbo and Cron (1988).

The actual number of classes is unknown and must be inferred from the model. We used Bozdogan's (1987) consistent Akaike's information criteria (CAIC) to determine the number of classes. The CAIC is defined as

$$\mathrm{CAIC} = -2 \ln L + (P \times C + C - 1)$$

The number of classes that best represents the data is chosen according to the minimum of CAIC. Moreover, for any set of latent classes, an entropy statistic, E_c, can be calculated in order to assess whether the classes are well separated. E_c is defined as

$$E_c = 1 - \sum_{i=1}^{I} \sum_{c=1}^{C} -\alpha_{is} \ln \alpha_{is} / I$$

where α_{is} is the posterior probability that individual i belongs to latent class c. The entropy statistic, E_c, is a relative measure bounded between 0 and 1, and describes the degree of separation in the estimated posterior probabilities of class membership. E_c values close to 1 indicate that the posterior probabilities of the individuals belonging to specific latent classes are, on average, close to 1 for their own class, and, on average, close to 0 for other classes. All analyses were conducted using MPLUS (Muthén and Muthén 2001).

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